

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

EEN3096 – COMMUNICATION ELECTRONICS
(TE / RE)

08 OCTOBER 2016
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages excluding cover page with 4 Questions only.
2. Attempt **ALL FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) Fig. Q1a shows a system of cascaded attenuators. The total attenuation is 20 dB.

- (i) Determine the value of resistors R_1 , R_2 , R_3 , and R_4 . [12 marks]
- (ii) Calculate V_{out} . [2 marks]
- (iii) What does it mean by 20dB attenuation? How would the system be affected with increasing attenuation? [1 + 1 marks]

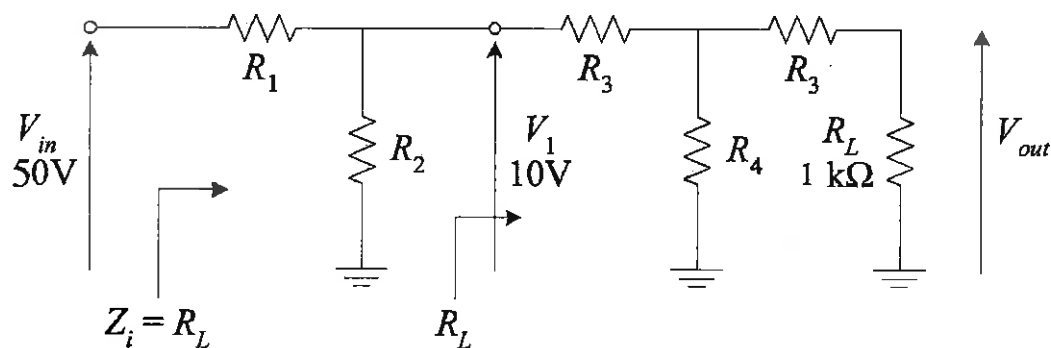


Fig. Q1a

(b) Fig. Q1b shows an L impedance matching network for a circuit with source impedance $R_s = 100 \Omega$ at resonant frequency 80 MHz.

- (i) Determine the value of load resistance R_L . [5 marks]
- (ii) Determine the value of the inductor L . [4 marks]

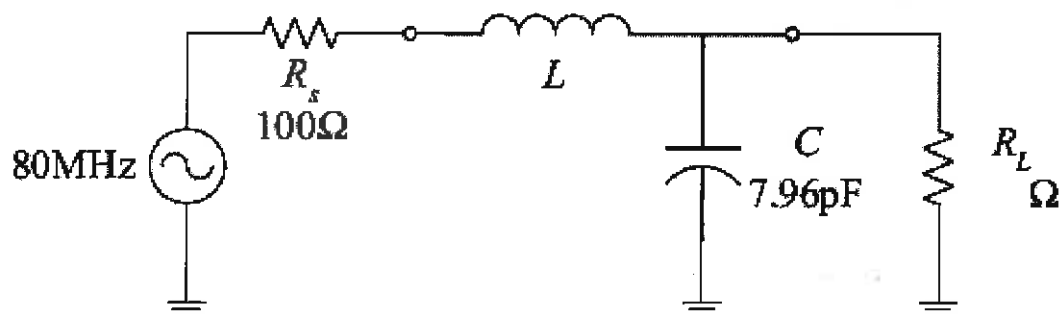


Fig. Q1b

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Question 2

- (a) Explain three considerations in designing an RF amplifier. [6 marks]
- (b) Define the term “transition frequency” in the context of amplifier design. [2 marks]
- (c) Fig. Q2 shows a simple tuned amplifier. The amplifier is designed to operate at 15 MHz with an operating bandwidth of 1 MHz. The transistor has the following parameters: $r_{bb'} = 60 \Omega$, $h_{fe} = 200$, $V_A = 50 \text{ V}$, $C_c = 12 \text{ pF}$, $f_T = 350 \text{ MHz}$ and $V_{BE} = 0.7 \text{ V}$. The transistor is biased at $I_C = 5 \text{ mA}$, $V_{CE} = 0.8 V_{CC}$ and $I_{Rb1} = 0.1 I_C$.
- (i) Determine the value of resistors R_{b1} , R_{b2} and R_e . [3 marks]
- (ii) Draw the hybrid- π model of the circuit with Miller's capacitance. [5 marks]
- (iii) Determine the value of all elements in the model drawn in part (ii). [6 marks]
- (iv) Determine the voltage gain A_V (in dB) of the amplifier. [2 marks]
- (v) How would the voltage gain A_V be affected with increasing load resistance R_L ? [1 mark]

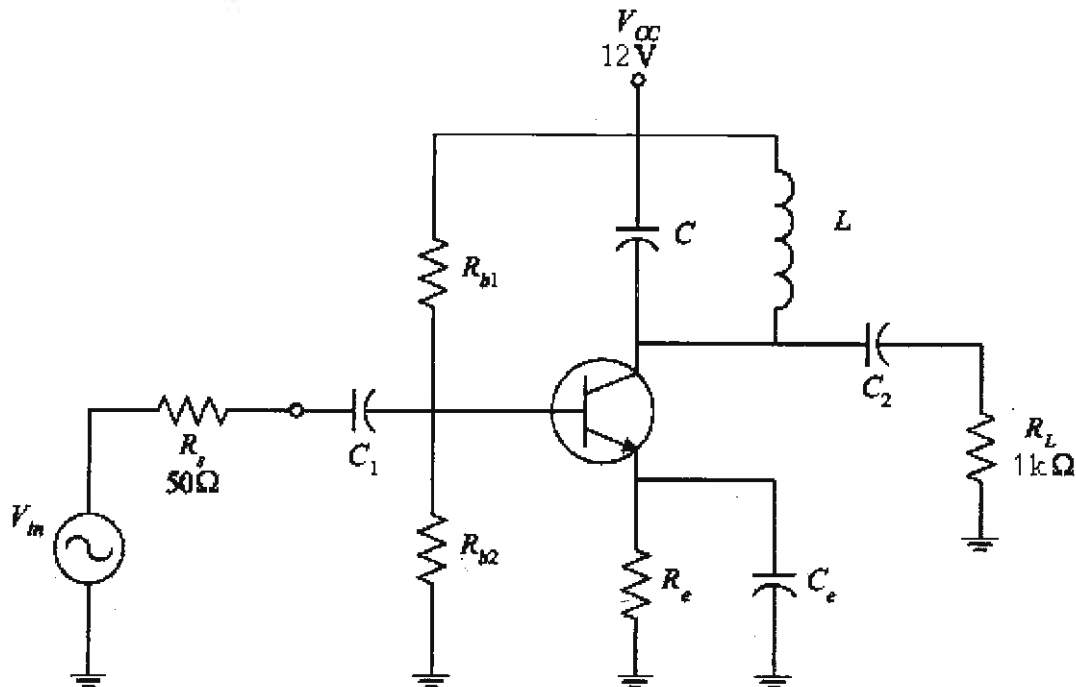


Fig. Q2

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Question 3

- (a) List out three essential components of a phase locked loop (PLL). [3 marks]
- (b) What is (i) capture range and (ii) lock range in a PLL? [8 marks]
- (c) A PLL with a VCO free-running frequency of 5 MHz has a 15% capture range and a 30% lock range. Over what frequency will the PLL be able to capture and subsequently maintain lock? [2 marks]
- (d) Fig. Q3 provides some information to analyze the static behavior of a PLL. Determine:
- (i) K_A of the amplifier. [1 mark]
 - (ii) The loop gain K_L in units of Hz/rad and decibels. [2 marks]
 - (iii) The loop gain K_v in units of s^{-1} and decibels. [2 marks]
 - (iv) The VCO output frequency when the system is locked. [1 mark]
 - (v) The static phase error, θ_e . [2 marks]
 - (vi) The hold-in range, Δf_H . [2 marks]
 - (vii) A , the maximum value of V_d . [2 marks]

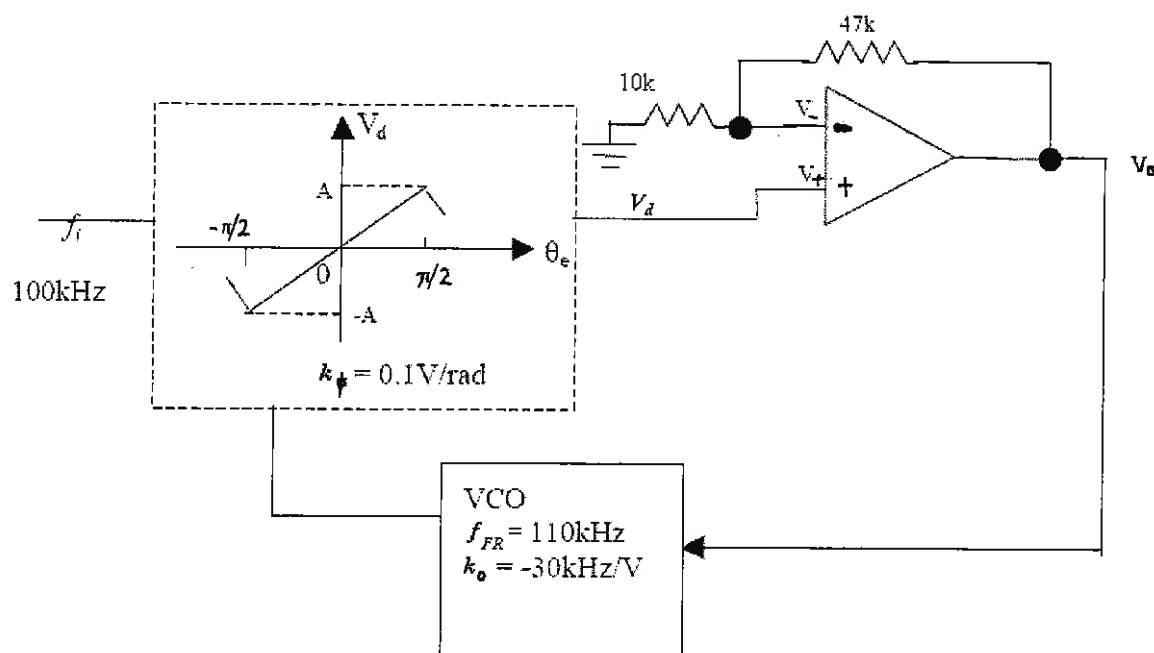


Fig. Q3

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Question 4

- (a) Explain the term “Plasma display” in Plasma TV. [3 marks]
- (b) Describe the basic operation of Plasma TV. [10 marks]
- (c) Compare the Plasma TV with Liquid Crystal Display (LCD) TV by stating 6 (SIX) advantages and 6 (SIX) disadvantages of Plasma TV over LCD TV. [6 + 6 marks]

Continued

Appendix – Useful Formulas

1. L impedance matching network (when $R_L > R_S$):

$$B = \frac{X_L \pm \sqrt{R_L / R_S} \sqrt{R_L^2 + X_L^2 - R_S R_L}}{R_L^2 + X_L^2} \quad X = \frac{1}{B} + \frac{X_L R_S}{R_L} - \frac{R_S}{B R_L}$$

$$Q = \frac{|X|}{R_S}$$

2. L impedance matching network (when $R_L < R_S$):

$$B = \pm \frac{\sqrt{(R_S - R_L) / R_L}}{R_S} \quad X = \pm \sqrt{R_L (R_S - R_L)} - X_L \quad Q = R_S |B|$$

3. π impedance matching network:

$$L = L_1 + L_2 = \frac{R_L}{\omega_o} \left(\sqrt{R_S / R_L - 1} + \sqrt{R_L / R_L - 1} \right)$$

$$C_1 = \frac{1}{\omega_o R_S} \sqrt{\frac{R_S}{R_L} - 1} \quad C_2 = \frac{1}{\omega_o R_L} \sqrt{\frac{R_L}{R_L} - 1} \quad Q = \sqrt{\frac{R_S}{R_L} - 1} + \sqrt{\frac{R_L}{R_L} - 1}$$

4. RF Class A transistor amplifier (Hybrid π model of BJT)

$r_{bb'}$	The base-spreading resistance.
g_m	The transconductance. $g_m = \frac{dI_C}{dV_{BE}} = \frac{qI_C}{kT} \cong \frac{I_C (\text{in mA})}{25.875 \text{ mV}}$ at $T=300\text{K}$, q = electronic charge, $1.6 \times 10^{-19} \text{C}$
C_e	The emitter capacitance.
$r_{b'e}$	The input resistance. $r_{b'e} = \frac{dV_{B'E}}{dI_B} = \frac{h_{fe}}{g_m}$
$r_{b'c}$	The collector to base resistance. $r_{b'c} = h_{fe} r_{ce}$
C_C	The collector capacitance.
r_{ce}	The output resistance. $r_{ce} \cong \frac{V_A}{I_C} = \frac{qV_A}{kTg_m}$ Where V_A is known as the Early voltage and I_C is the dc collector current.

Continued

5. High frequency Class A amplifier parameters:

(a) Voltage gain:

$$A_V = \frac{v_o}{v_{BE}} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{r_{bb'} r_{b'e}}{r_{bb'} + r_{b'e}}}$$

In cases where $r_{bb'} \ll r_{b'e}$ then

$$A_V = \frac{v_o}{v_{BE}} = -\frac{g_m R_o}{1 + j\omega C_T r_{bb'}}$$

(b) Effective voltage gain (including the effect of source impedance R_S):

$$A_{VS} = \frac{v_o}{V_S} = -g_m R_o \frac{r_{b'e}}{r_{bb'} + R_S + r_{b'e}} \frac{1}{1 + j\omega C_T \frac{(R_S + r_{bb'}) r_{b'e}}{R_S + r_{bb'} + r_{b'e}}}$$

In cases where $(R_S + r_{bb'}) \ll r_{b'e}$ then

$$A_{VS} = \frac{v_o}{V_S} = -\frac{g_m R_o}{1 + j\omega C_T (R_S + r_{bb'})}$$

Where $C_T = C_e + C_M$ and $C_M = \text{Miller capacitance } C_M = (1 + g_m R_o) C_C$

(c) Transition frequency

$$f_T = \frac{1}{2\pi} \frac{g_m}{C_e + C_C}$$

(d) Input impedance

$$Z_i = r_{bb'} + \frac{r_{b'e}}{1 + j\omega r_{b'e} C_T}$$

End of Paper